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Colt Industries
Chandler Evans
Control Systems Division



WEST HARTFORD, CONNECTICUT 06101

Approved for
[illegible]

Colt Industries



Chandler Evans Inc
Control Systems Division
Charter Oak Boulevard
West Hartford, Conn. 06101
203/236-0651

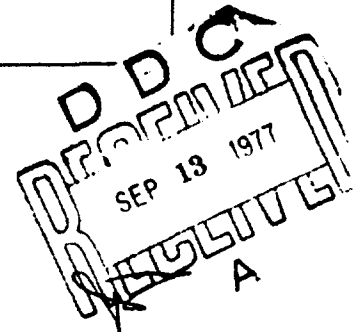
FINAL REPORT
CONTROL SYSTEMS FOR
5" GUN LAUNCHED GUIDED PROJECTILE
NSWC-DAHLGREN

CONTRACT NO: N00178-75-C-0040

ENGINEERING REPORT NO. R-787

WORK ORDER NUMBERS 4754, 4744

DATE June 9, 1975



WRITTEN BY:

D.J. Pearman

REVIEWED BY:

P. Evans
P. Evans, Senior Project Engineer

APPROVED BY:

P.T. Glover
P.T. Glover, Manager, Flight Controls

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APPROVED

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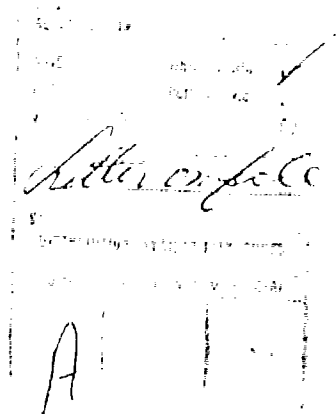
ABSTRACT

The report documents the work performed under NSWC/
Dahlgren Contract No. N00178-75-C-0040.

During the course of the contract, thirty-three (33) systems with twenty-seven (27) power supplies and five (5) argon gas containers were successfully developed, built, tested and shipped to NSWC/Dahlgren.

This report contains a system description, program summary, and the resulting test data.

Recommendations submitted are that, although a reliable, workable system now exists, substantial re-evaluation and redesign will be required to arrive at a more economical, production unit.



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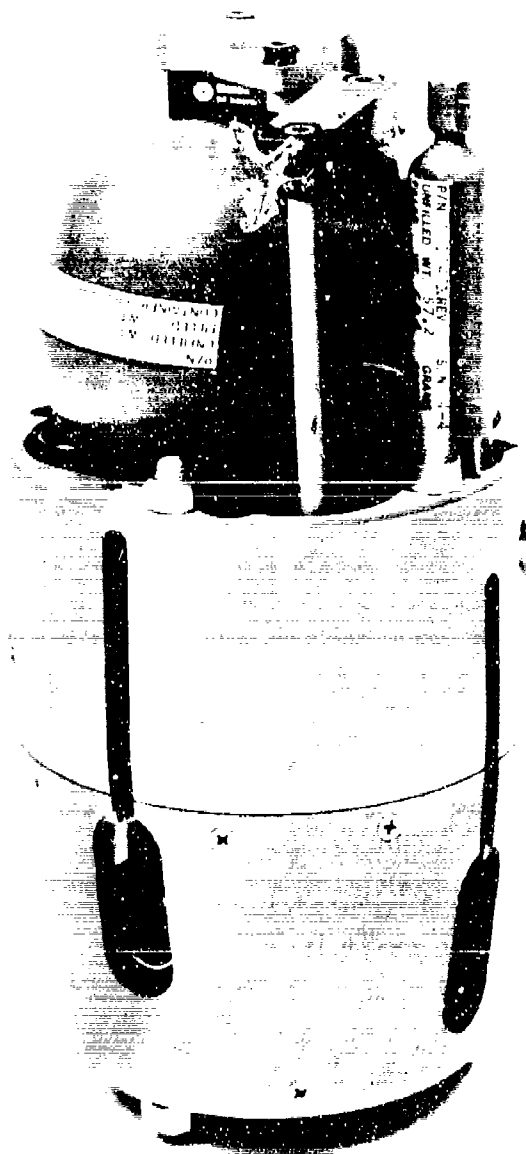
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1.0 INTRODUCTION

The Naval Surface Weapons Center in Dahlgren, Virginia issued a contract No. N00178-75-C-0040 to reevaluate and refine the design, develop, and fabricate thirty-eight (38) CACS-28 control systems for the 5 Inch Gun Launch Guided Projectile.

The report will document the design, development and results of the above contract.



CACS-28-5 FLIGHT CONTROL
5" GUIDED PROJECTILE
CONTROL SYSTEM
CANARDS STOWED

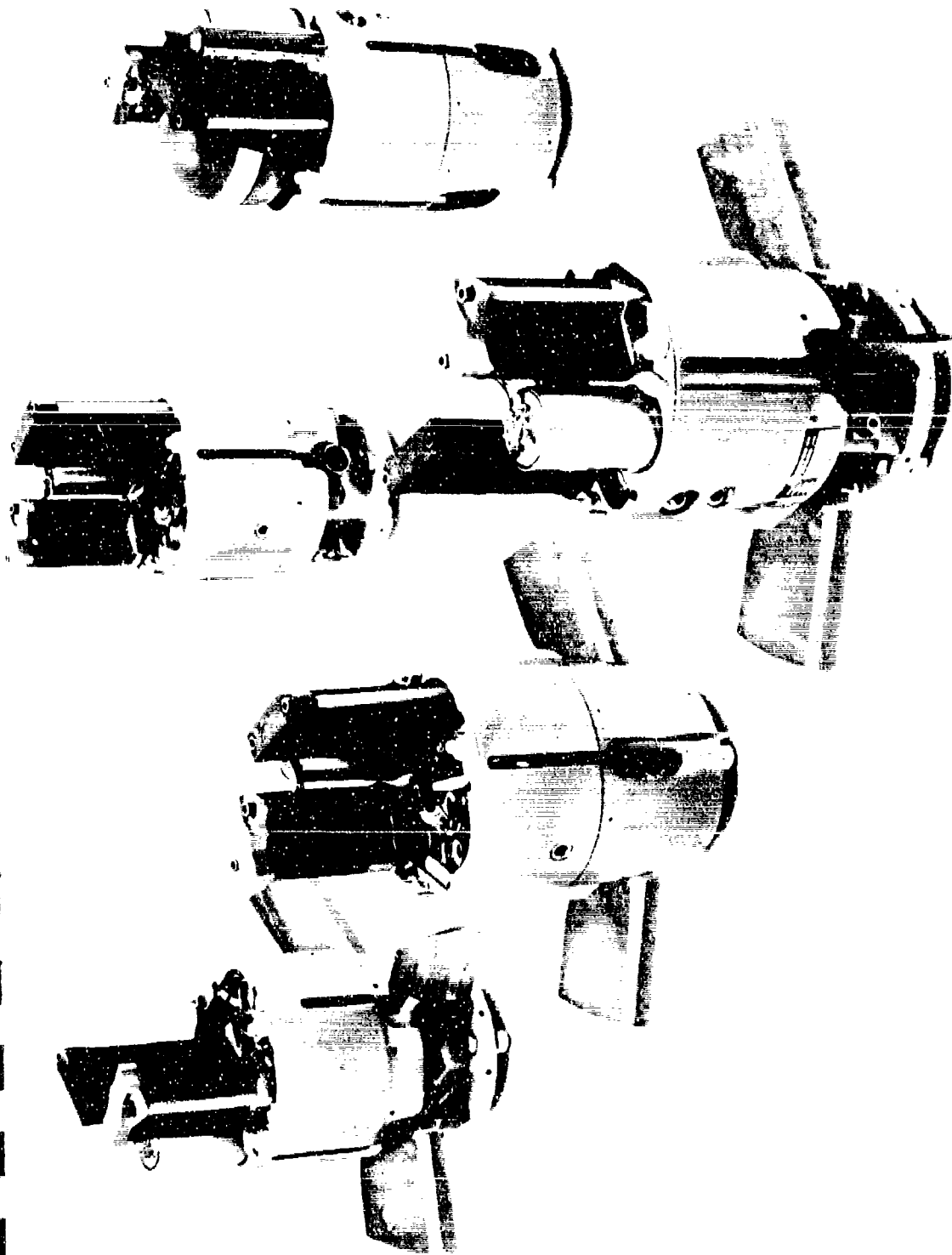
Model # CACS-28-5

Prod. Cat. FLIGHT CONTROL

CE-A-8827




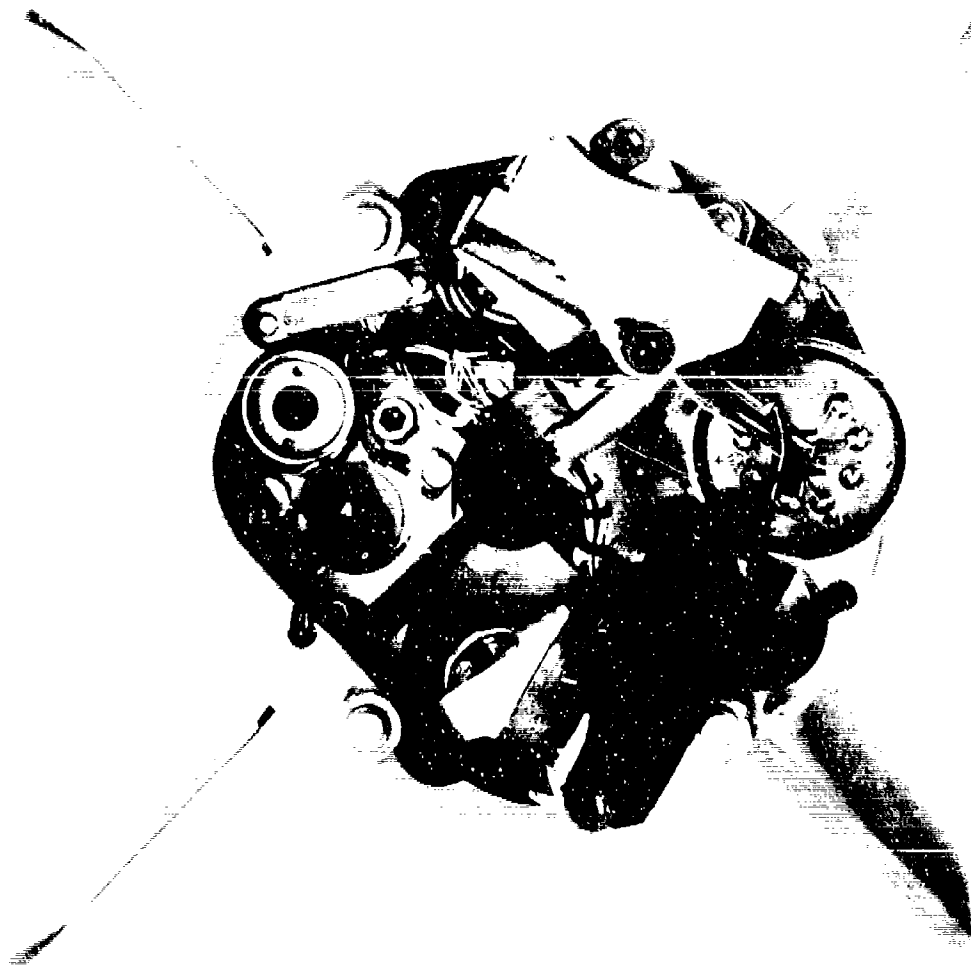
Colt Industries
Chandler Evans
Control Systems Division



CACS-28-5 FLIGHT CONTROL
5" GUIDED PROJECTILE
CONTROL SYSTEM


Model # CACS-28-5
Prod Cat. FLIGHT CONTROL
CE-A-8830

 **Calt Industries**
Columbus, Ohio
Control Systems Division



Model # CACS-28-5
 Prod. Cat. FLIGHT CONTROL
 CE- A-8832

CACS-28-5 FLIGHT CONTROL
 5" GUIDED PROJECTILE
 CONTROL SYSTEM
 AFT LOOKING FORWARD CANARDS DEPLOYED
 HE AND ARGON CONTAINER REMOVED

 **Celt Industries**
 Chandler Evans
 Control Systems Division

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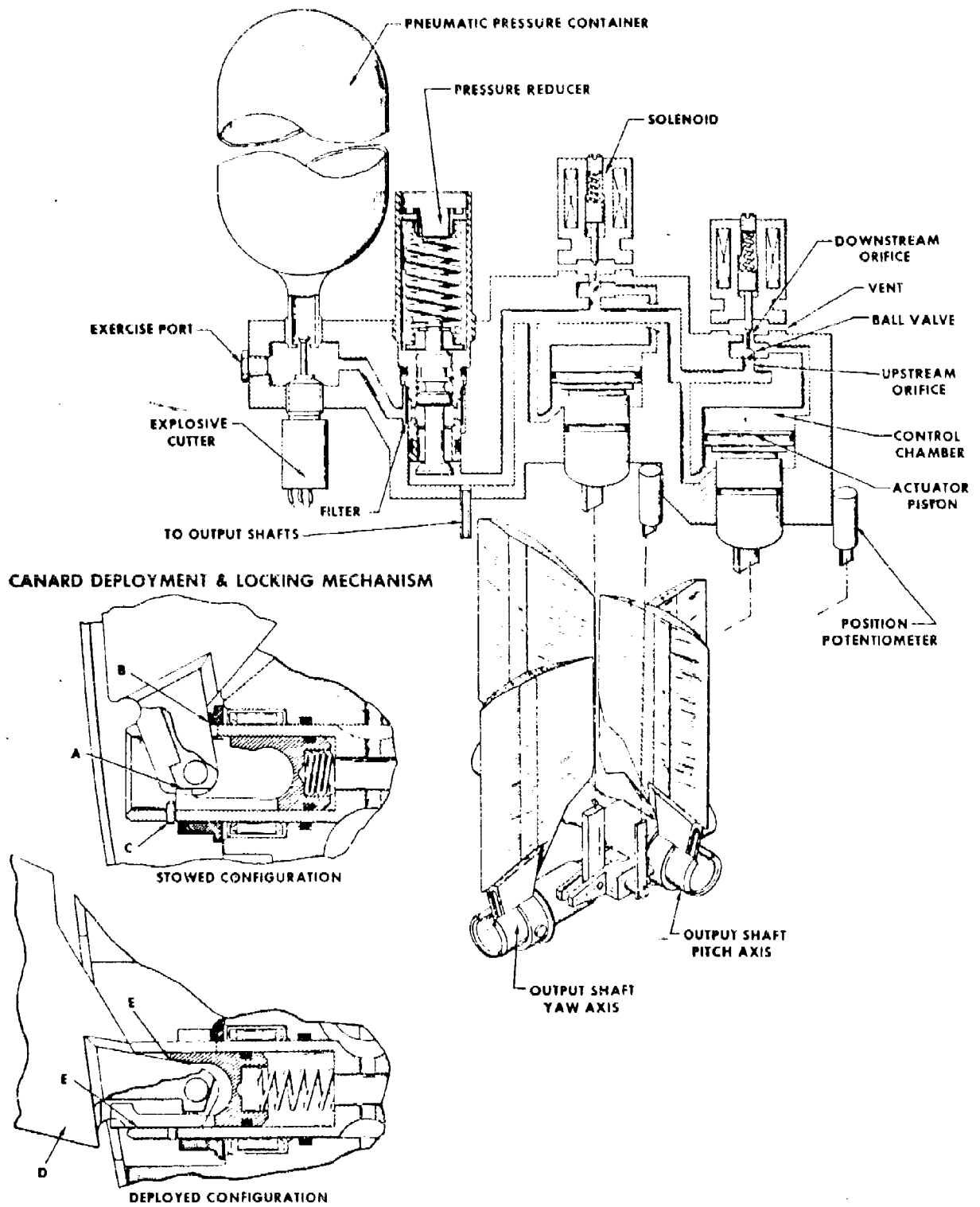
2.0

SYSTEM DESCRIPTION (Reference Figures 1 & 4)

The system is initiated by applying a current pulse to the Explosive Actuated Cutter (See Figure 1). This causes the bottle cutting ram to extend and puncture the metal diaphragm seal cap on the gas container. High pressure helium is then allowed to flow through a filter, incorporated in the reducer, to the inlet side of the pressure reducer. This filter prevents any contamination that may be present in the gas container or caused by the cutting of the seal, from entering the reducer and producing damage to the metering orifices. The pressure reducer consists of a spring loaded conical poppet valve incorporating a single sensing area.

Helium reduced to the operating pressure range is then distributed to the two differential areas actuators and the four deployment pistons. These deployment pistons are contained within the two output shafts. The piston performs the joint function of locking the canards in both the stored and deployed conditions, and also deploying the canards when pressurized.

In the stowed condition the canard is locked between the piston's locking tag (A) and the face of the collar/crank (B). The piston moves out along the shaft bore, cutting through the aluminum shear pin (C) and swinging the canard out to



CACS-28 SCHEMATIC

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its deployed position (D). The canard is then locked in place between the pneumatically loaded piston and shaft (E).

The design is a refinement of that used in the CACS-28-4 system, Reference Section 3.1.1.

At each actuator, helium is ported to the rod side of the actuator piston and the ball valve assembly. The ball valve operates such that when the ball is seated against the upstream orifice, the inlet flow is cut off and the control chamber is vented to ambient. Alternately, when the ball is seated against the downstream orifice, the vent port to ambient is closed and helium flows through the upstream orifice to the control chamber.

The valve ball is positioned by the solenoid plunger. With the solenoid de-energized, the spring preload forces the plunger to extend and positions the ball against the upstream orifice. When the solenoid is energized, the plunger is pulled back into the solenoid body and allows pneumatic pressure to seat the ball against the downstream orifice.

The state of the solenoid is controlled by the output signal from the Driver electronics package. This solenoid signal is a result of the input command and position feedback information.

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Basically, the electronics package consists of a carrier generator circuit coupled to two (2) summer/modulators and output stages.

The operation of the driver package is as follows. The carrier generator generates the switching wave of desired frequency and amplitude, the frequency of which determines the rate at which the solenoid is commanded to switch.

Varying the carrier amplitude allows control of the Actuator electrical gain.

The carrier, command input and actuator position feedback signals are algebraically added in the summer, Figure 2 the resultant output being fed to the modulator.

The modulator converts the variable d.c. level sawtooth into a square wave of the same frequency with a duty cycle dependent on the resultant of the command and feedback signals, Figure 3

It is this signal which, after passing through a power output stage, appears on the solenoid terminals.

In practice the time modulated system with a carrier frequency normally between 75 and 150 Hz produces an on and off time of the solenoid of such a short interval that the gas flow in or out of the valve per cycle is small.

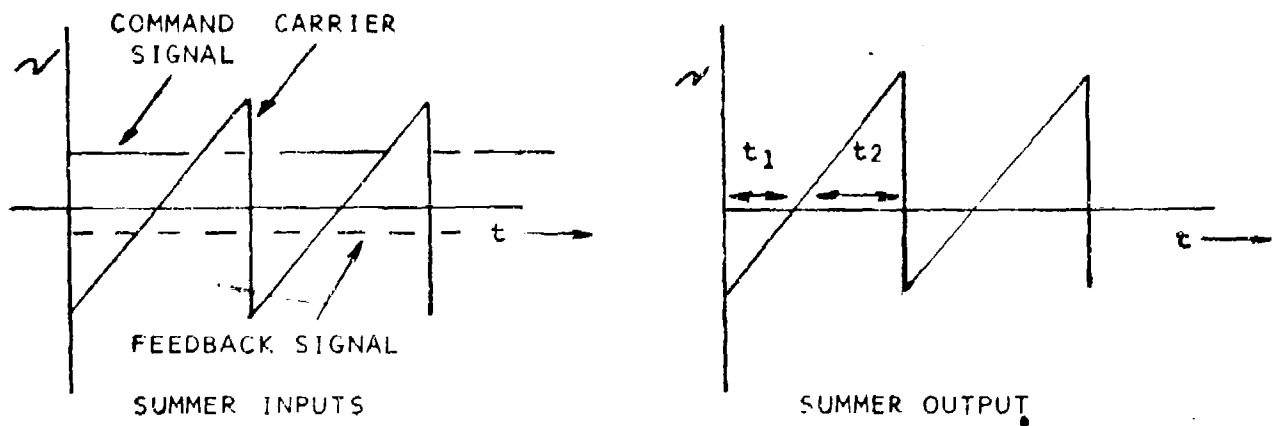


FIGURE 2

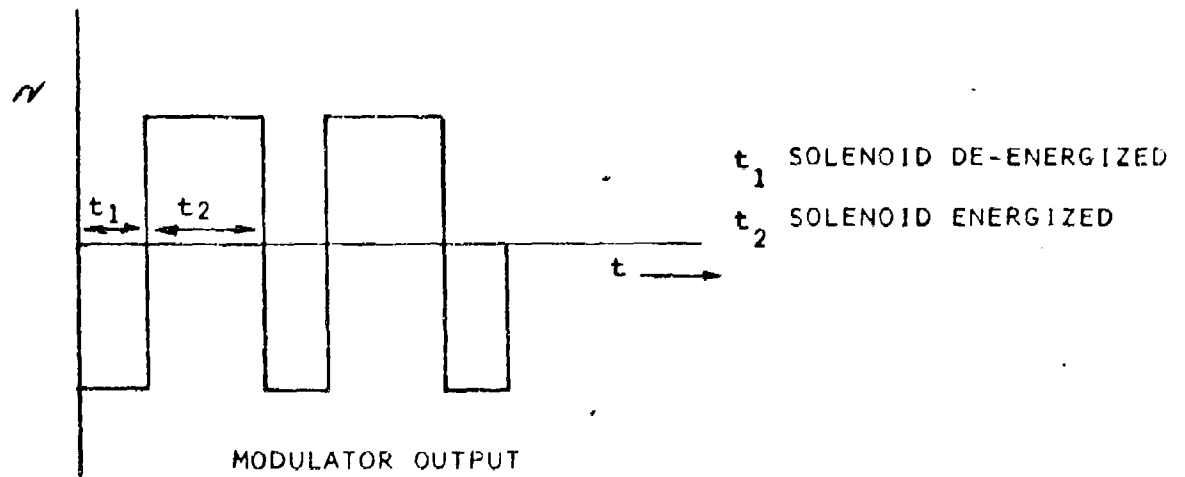


FIGURE 3

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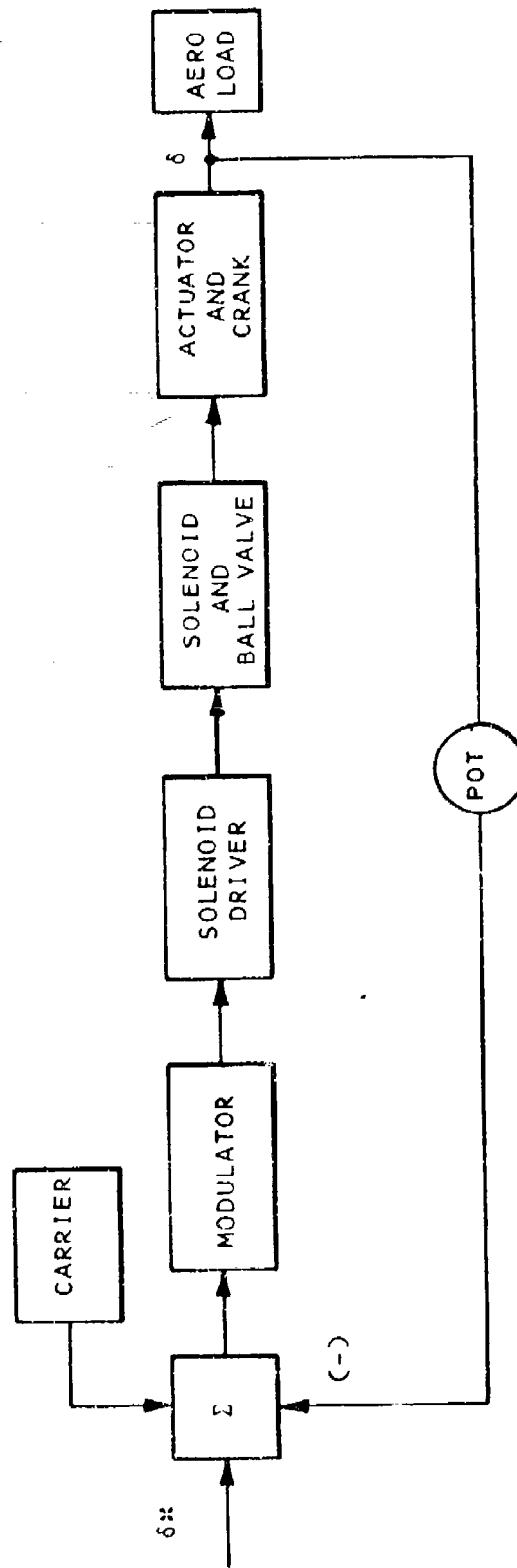
If, due to the summation of the command and feedback signal, there results a modulator output so that the on and off time of the solenoid is greater or less than the 50% condition, a net flow in or out of the control chamber will occur. This produces an increase or decrease in the pressure on the large side of the actuator piston. Due to the phasing of the system, this will cause the piston to move so as to reduce the error signal, thereby returning the modulator output to a 50% condition.

Each differential area actuator drives a shaft to which two canards are mounted. When the pressure in the control chamber acting on the larger effective area of the actuator piston, is greater than null, i.e., 50% of supply, the piston will extend.

Conversely, the piston will retract when modulated chamber pressure drops below the null level. By employing the position potentiometer to provide negative feedback, a position proportional system is obtained.

δ^* - COMMAND POSITION

δ - CANARD POSITION



SIMPLIFIED SYSTEM BLOCK DIAGRAM

Figure 4

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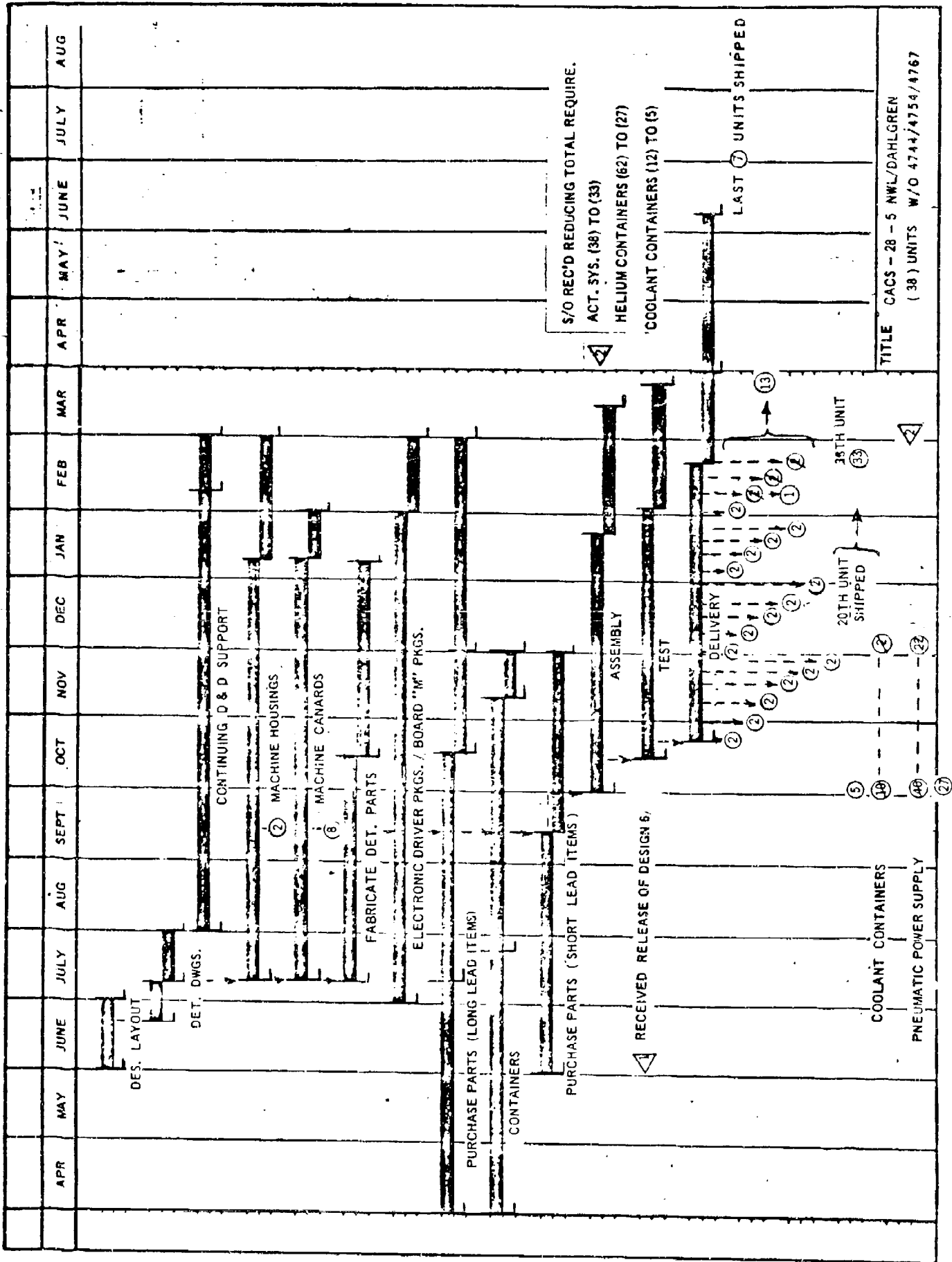
3.0 PROGRAM SUMMARY

On June 3rd 1974 NSWC authorized CE to commence design work required on the contract for thirty-eight (38) systems.

Work was initiated and proceeded along until July 1st when a preliminary design review was held with NSWC. At that time several changes were agreed to be incorporated, before the final review, which was held on July 11th.

The number of systems actually delivered was reduced from thirty-eight (38) to thirty-three (33) per NSWC request, during the month of November. This was accompanied by reductions in Helium power supplies from sixty-two (62) to twenty-seven (27) and Argon Containers from twelve (12) to five (5).

The actual program schedule is contained in Figure 5.



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3.1 System Changes

The control systems supplied on the contract differ from those previously manufactured under contract N00178-74-0255 in the following areas.

3.1.1 Canard Deployment Re-design

The previous contract for ten (10) CACS-28 actuators had revealed deficiencies in the implementation of the canard deployment concept. These deficiencies are listed below.

- a. Deformation of deployment piston after deploying canard, thus resulting in the inability to restow the canards successfully.
- b. Difficulty in retaining the canard within the actuator envelope when in the stowed configuration.
- c. Indentation of the shank of the canard due to impact from the deployment piston during pressurized activation.

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The problem of piston deformation resulted from the fact that when the canards deployed they were locked in position by a wedge formed by the two prongs of the piston, Figure 1, which in the case of the locking tag (A), first was not supported by the shaft. This resulted in a tendency for the piston tag to bend, therefore, making it impossible to restow the piston successfully.

3.1.1.1 Redesign Implementation

As the result of a NSWC canard aerodynamic modification which substantially reduced the volume of material comprising the canard, it was possible to fabricate from steel. This was possible without placing undue loading on the shafts and removed the problem of indentation of the canard shank during deployment.

A tolerance layout investigation was made to ensure that the forthcoming design would not, under adverse conditions, allow the canard leading edge to penetrate the outside diameter of the control section in the stowed position. These investigations were performed in conjunction with the redesign of the deployment mechanism. This redesign enabled the canard, when deployed, to be locked in the deployed position by the wedging action between the piston

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and shaft. The stowed locking prong now being recessed in a slot in the canard shank and relieved of any loading when the canards are deployed. As a result of the tolerance study the dimensioning of the locking prong and its mating canard surface relative to the hinge pin and shaft was such that movement at the canards outboard edge would be restricted in the stowed condition. Thus to contain the canards within the actuator outside diameter and also to limit total amount of canard "play". Realizing that there was a 40 to 1 amplification factor of any movement between the shank and outboard edge of the canard, very tight dimensioning of the detail parts was required.

3.1.2 Argon Gas passage Redesign

To reduce the assembly time and eliminate the chance of uncured loctite contamination in the argon gas passage, it was planned to dispense with the insert.

It was found, however, that the incorporation of the narrow passage in the housing would have proven expensive. This because of the long narrow passage necessitated by the layout Drawing No. 701450X and NSWC volume requirements.

The utilization of the insert concept was therefore justified. To avoid the problems previously encountered, the sintered metal filter element was located at the downstream

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end of the passage. A threaded insert performed the dual role of clamping the filter in place and reducing the passage volume to NSWC requirements.

The design proved both cost effective and reliable.

Cost effective in that the same housing thread was used for the filter insert and the argon container and reliable as there was no risk of unfiltered gas or lockite reaching the capillary tube.

3.1.3 Forward Connector

The forward connector was repositioned so as to be mounted on the forward side of the housing flange. This was an NSWC requested change.

A cross slot in the housing flange was necessary to facilitate installation of the connector from the aft side. The incorporation of the preformed harness, ref. Section 3.1.5 had introduced this requirement.

3.1.4 Pressure Transducer Installation

The pressure transducers lack of survivability during gun launch had frequently proven to be an annoying problem. The

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very thin leads between the transducer body and the balance board would break during the launch.

To rectify this problem shrink tubing was placed between the transducer body and balance board and the board recessed in a slot on the aft face of the housing. The arrangement was then held in place by a cover plate.

3.1.5 Preformed Harness

The harnessing on the CACS-28-4 system was basically preformed on an individual basis with the number of splices totaling approximately 70.

In an effort to improve the reliability and cost of the harnessing, along with the advantageous ability to replace packages in a short time, the following harnessing scheme was evolved.

The harness was to be a preformed harness having four connectors; two, the 37P and 31S necessary for mating with NSWC housings and a 15P and 15S for mating with the driver and voltage regulator.

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Preliminary layouts of the harness were made and discussions with several potential vendors were undertaken.

ITT Cannon was selected due to the following reasons:

a) NSWG requirement of Cannon connectors, b) difficulty of alternate vendors to work with these connectors, c) cost, and d) expertise that ITT Cannon had with this type of project.

Several discussions were at Cannon among NSWG, Cannon and CECO to develop the optimum configuration. This resulted in substantial re-routing of the wiring from that on the CACS-28-4.

The harness has improved the reliability and serviceability of the system due to the following factors.

- a. Check out of harness continuity prior to installation.
- b. Substantial reduction in number of splices 32 instead of 70.
- c. Removal of necessity to splice in different areas.

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- d. Greatly reduced bundle size allowing easier installation and routing.
- e. Ease of removal and replacing Driver and Voltage regulator packages.
- f. Reduction in assembly and test time.

Of all the advantages gained by employing the preformed/plug-in harness, the ability to interchange packages quickly and easily without disturbance to the harness, has proven to be the most rewarding. Several times during the course of the program there has been a need to change one or both of the packages. On these occasions the procedure has been completed within 10 minutes. This compares favorably with 5-8 hours to perform the identical procedure on a CACS-28-4 system.

3.1.6 Redesign of Electronic Package

To facilitate mating with the preformed harness, it was necessary to rework the driver and voltage regulator package layouts in order to incorporate the mating connectors. This resulted in a slight increase in the overall envelope which necessitated minor changes to the valve housing so as not to violate the NSWC specified, overall system envelope.

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3.1.7 Valve Modifications

Based on the experience gained with the valves on the CACS-28-4 new inputs and a redesign was undertaken to implement the improvement developed. The changes made are as follows:

- a. Re-tolerancing of component to improve alignment of solenoid plunger and ball.
- b. Incorporation of sintered metal filter in lower seat to provide additional filtration protection.
- c. Change to solenoid plunger and bore finishing process to remove problem of galling between the two parts.
- d. Modification of valve housing to achieve overall height reduction required by the mounting of the plug electronic packages.

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3.2 Development Problems

During the course of the program, few hardware problems were encountered, the only two worthy of inclusion in the report are as follows:

3.2.1 Driver Package Failures

During fabrication several of the driver packages exhibited oscillation on the carrier waveform. This would have produced system instability and they were not used.

One unit, however, driver package P/N 101526X, S/N 307 which was returned by NSWC after removal from System 4ADV003, did indicate severe instability.

Further details of this unit may be found in January and February Monthly Progress Reports.

Complete details of investigation performed on the driver electronic packages are contained in Report S-297.

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3.2.2 Harness - Forward Connector

Due to what proved to be misalignment of the shorting connector sockets, the forward connectors on six (6) systems were damaged.

NSWC authorized, vendor recommended repairs were carried out, resulting in fully acceptable system.

Details of the above may be found in April/May Progress Reports.

Later communication from the vendor, contained assurances that the problem would not be repeated.

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4.0 SUMMARY OF TEST RESULTS

The schedule of acceptance test and shipping data for the thirty-three (33) systems supplied is shown in Table 1.

As the volume of test data obtained from this number of systems is large it was decided to present the data from one representative actuator, Appendix A, along with Table 2 which contains in condensed form the data from all the systems.

Results of several system gas container blowdowns are contained in Appendix B.

The acceptance test performed on these systems was per PSM-1210.

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5.0 CONCLUSIONS

The incorporation of many design modifications resulting from the experience gained with the CACS-28-4 has resulted in an actuator system which has proven to be an overall more successful unit. Some of the improvements are as follows:

- a) Reductions in Assembly and Test time.
- b) Improved valve performance.
- c) Conformity of system appearance and performance.
- d) Workability in canard deployment and stowing mechanism.

The systems performed well through the acceptance tests and have, based on information received from NSWC/DL, performed their tasks satisfactorily in the field.

Two systems were returned, however, S/N 4ADV011 because of a damaged forward connector and S/N 4ADV015 due to gas leak around the pitch shaft.

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The leak on S/N 4ADV015 was due to cut shaft o-rings. This was the first such incident of cut o-rings on the shaft and on investigation no apparent cause could be found. Previous incidents of cut o-rings had appeared on the deployment piston o-rings. Revised fabrication and assembly techniques had satisfactorily eliminated the problem.

6.0 RECOMMENDATIONS

The control systems will require further modification and redesign to become a economically manufactured item.

The more substantial of the changes are discussed below.

6.1 Canard Stowing and Deployment Mechanism

Although the present scheme works satisfactorily in all operational aspects it does require tightly toleranced parts such as canard, shaft and pistons. All of these parts have been shown to be excessively expensive to produce in production.

A redesign study should be undertaken to develop an equally operable scheme without the high degree of exact dimensioning now required.

6.2 Electronic Packaging

It would appear advantages from an envelope and cost point of view to combine the Driver and Voltage Regulator electronics into one package of the approximate size of the present Voltage Regulator package.

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In order to obtain this size reduction, an intensive packaging redesign will be needed utilizing the characteristics of modular component arrangements.

6.3 Harness

The incorporation of the preformed harness while proving in its present form to possess many advantages over the "in situ" arrangement, will require re-evaluation for the productionized control.

This should involve the combining of the harness and electronics package into one sub-assembly. The resulting cost savings being the removal of two connector pairs, support brackets and miscellaneous hardware.

As a consequence, the "plug in" feature of the present design will no longer exist, but it should be considered, that where a substantial cost savings is involved this feature cannot be justified in production hardware.

6.4 General Comments

A complete and total cost reduction design study is in order to arrive at a suitable production item.

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To this end, in addition to the points mentioned above, redesign of the control housing along with review of such components as the cutter, reducer, potentiometer and solenoids are necessary.

These efforts, in conjunction with the continuing aim of improving system performance, will result in a productionable control with good operating characteristics.

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TABLE 1

<u>SYSTEM SERIAL NO.</u>	<u>ACCEPTANCE TEST</u>	<u>SHIPMENT</u>
4ADV001	10-21-74	10-25-74
4ADV002	11-2-74	11-8-74
4ADV003	11-21-74	11-27-74
4ADV004	11-22-74	11-27-74
4ADV005	11-22-74	11-27-74
4ADV006	11-22-74	11-27-74
4ADV007	12-9-74	12-13-74
4ADV008	12-9-74	12-13-74
4ADV009	12-9-74	12-13-74
4ADV010	12-9-74	12-13-74
4ADV011	1-16-75	2-4-75
4ADV012	12-19-74	1-29-75
4ADV013	12-19-74	1-29-75
4ADV014	12-19-74	1-29-75
4ADV015	12-19-74	1-29-75
4ADV016	12-19-74	1-29-75
4ADV017	1-16-75	2-4-75
4ADV018	1-16-75	2-4-75
5ADV019	1-16-75	2-4-75
5ADV020	1-16-75	2-4-75
5ADV021	4-8-75	5-30-75
5ADV022	4-8-75	5-39-75
5ADV023	4-8-75	5-30-75

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TABLE 1 (Cont'd)

<u>SYSTEM SERIAL NO.</u>	<u>ACCEPTANCE TEST</u>	<u>SHIPMENT</u>
5ADV024	4-8-75	4-30-75
5ADV025	4-8-75	4-30-75
5ADV026	4-9-75	4-30-75
5ADV027	4-9-75	4-30-75
5ADV028	4-9-75	5-30-75
5ADV029	4-9-75	4-30-75
5ADV030	4-9-75	5-30-75
5ADV031	4-9-75	4-30-75
5ADV032	5-16-75	5-30-75
5ADV033	4-9-75	5-30-75

	4ADV001	4ADV002	4ADV003	4ADV004	4ADV005	4ADV006	4ADV007	4ADV008	4ADV009
<u>CANARD TRAVEL</u>									
PITCH EXTEND (DEG.)	10.15	10.67	10.83	10.58	10.43	10.58	10.33	10.50	10.5
RETRACT (DEG.)	10.25	10.30	10.40	10.25	10.58	10.25	10.67	10.67	10.1
YAW EXTEND (DEG.)	10.58	10.33	10.67	10.58	10.42	10.17	10.67	10.67	10.6
RETRACT (DEG.)	10.42	10.58	10.50	10.25	10.67	10.42	10.67	10.67	10.2
<u>FREQUENCY RESPONST AT 5 HZ</u> (REF. MAG ZERO DB AT .5 HZ)									
PITCH MAG (DB)	0	0	0	0	0	0	0	0	0
PHASE (DEG.)	18.7	19.0	20.0	20.0	19.0	21.0	18.0	20.0	18.1
YAW MAG (DB)	0	0	0	0	0	0	+0.4	+0.1	0
PHASE (DEG.)	18.5	18.0	19.0	19.0	18.0	21.0	20.0	20.0	18.
<u>SLEWING VELOCITY (LOADED)</u>									
PITCH (DEG./SEC.)	234	228	228	222	228	228	242	242	239
YAW (DEG./SEC.)	240	233	246	228	234	228	258	234	255
X-Y PLOTS SEE NOTE 1	OK	OK	OK	OK	OK	OK	OK	OK	OK

NOTE:

1. ALL X-Y PLOTS WERE WITHIN THE SPECIFICATION REQUIREMEN
DICTATED BY FIGURE 6 AND FIGURE 7

CACS-28-5 PERFORMANCE DATA

4ADV009	4ADV010	4ADV011	4ADV012	4ADV013	4ADV014	4ADV015	4ADV016	4ADV017	4ADV018	4ADV019	4ADV020	4ADV021	4ADV022
10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67
10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67
10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67
10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67
0	0	0	0	0	0	0	0	0	0	0	0	0	0
20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
+0.1	0	0	+0.5	+0.5	0	0	0	+0.1	0	0	+0.4	0	+0.2
20.0	20.0	24.0	17.0	15.0	13.0	13.0	14.0	21.0	16.0	21.0	16.0	16.0	14.0
242	239	249	246	250	256	237	227	241	239	246	252	233	242
234	255	228	266	256	270	250	245	255	259	225	279	250	260
OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK

REQUIREMENTS

2

5ADV019	5ADV020	5ADV021	5ADV022	5ADV023	5ADV024	5ADV025	5ADV026	5ADV027	5ADV028	5ADV029	5ADV030	5ADV031	5ADV032	5ADV033
10.71	10.15	10.17	10.00	10.08	10.00	10.33	10.00	10.00	10.00	10.17	10.17	10.17	10.08	10.08
10.00	10.75	10.83	10.83	10.67	10.92	10.50	10.67	10.50	10.33	10.50	10.83	10.83	10.33	10.75
10.75	10.00	10.17	10.00	10.00	10.00	10.50	10.00	10.17	10.00	10.00	10.00	10.00	10.33	10.00
10.7	10.50	10.83	10.58	10.67	10.83	10.17	10.50	10.17	10.33	10.33	10.50	10.17	10.25	10.67
0	0	+0.2	-0.1	+0.2	-0.1	+0.35	-0.2	-0.2	0	-0.1	-0.05	-0.5	+0.3	+0.1
10	10.0	14.0	14.0	14.0	17.0	16.0	15.0	15.0	14.0	14.0	16.0	14.0	20.0	14.0
14	0	+0.1	-0.25	+0.1	+0.1	-0.1	-0.1	-0.2	-0.1	-0.3	-0.1	-0.1	+0.5	+0.1
10	10.0	14.0	14.0	14.0	16.0	16.0	15.0	14.0	14.0	15.0	12.0	17.0	16.5	15.0
2	233	242	2	245	222	227	217	219	225	236	248	270	239	245
9	250	260	9	263	224	215	217	239	252	227	278	225	252	248
OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK

OVERLAY

CACS-28-5 PNEUMATIC CONTROL

TEST CONDITION

UNLOADED

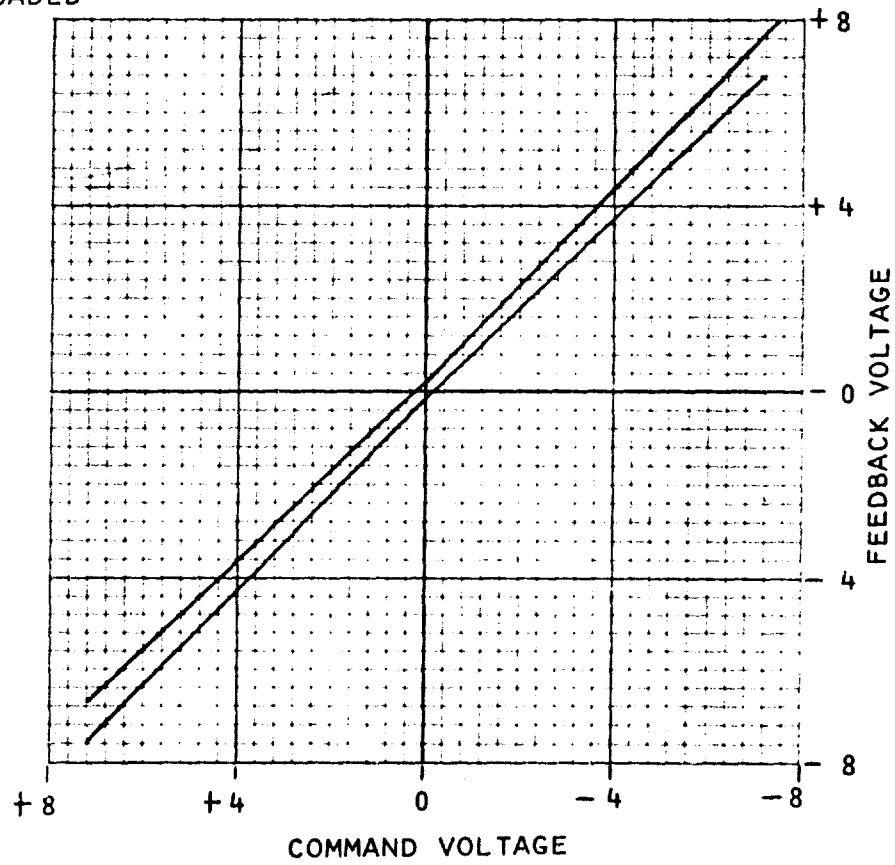


FIGURE 6

OVERLAY

CACS-28-5 PNEUMATIC CONTROL

TEST CONDITION

LOADED AT 14 LB IN/DEG (PER AXIS)

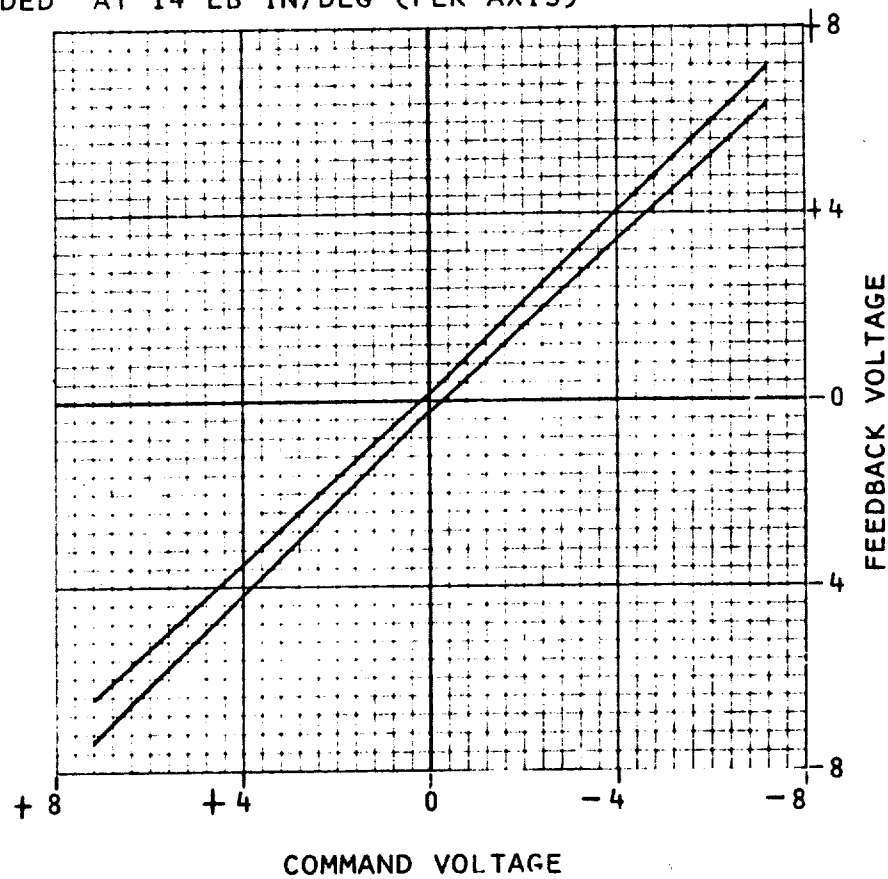


FIGURE 7

ENG. REPORT NO. R-787 DATE June 9, 1975

APPENDIX A

ACCEPTANCE TEST RESULTS OF SYSTEM S/N SADV028

AMPLITUDE RATIO VS. FREQUENCY

AMPLITUDE RATIO (dB)

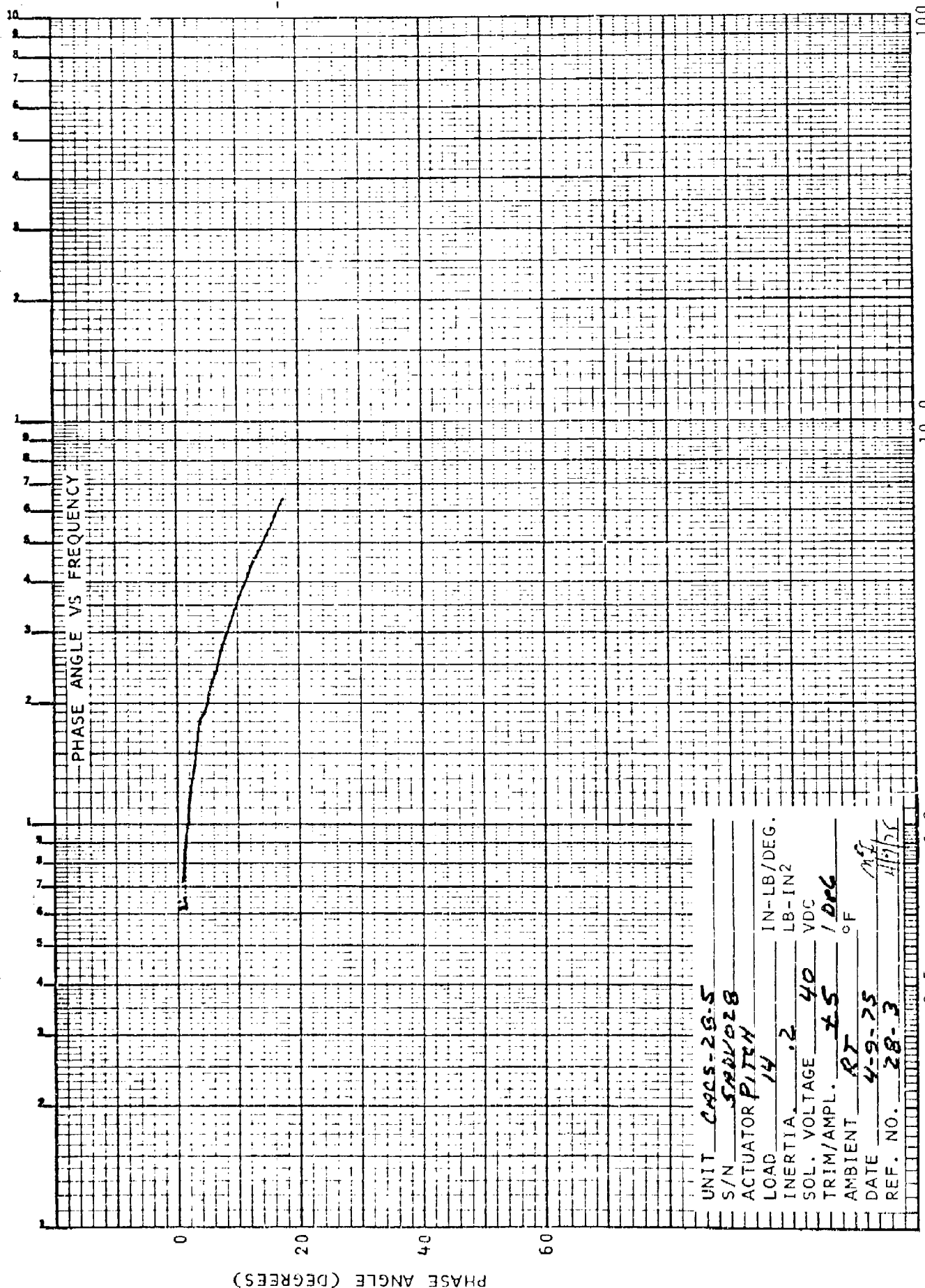
FREQUENCY (HERTZ)

UNIT CNCS-28-5
 S/N 500028
 ACTUATOR PITCH
 LOAD 14 IN-LB/DEG.
 INERTIA 12 LB-IN²
 SOL. VOLTAGE 40 VDC
 TRIM/AMPL. 45 / 100
 AMBIENT RT °F
 DATE 4-9-25
 REF. NO. 28-4

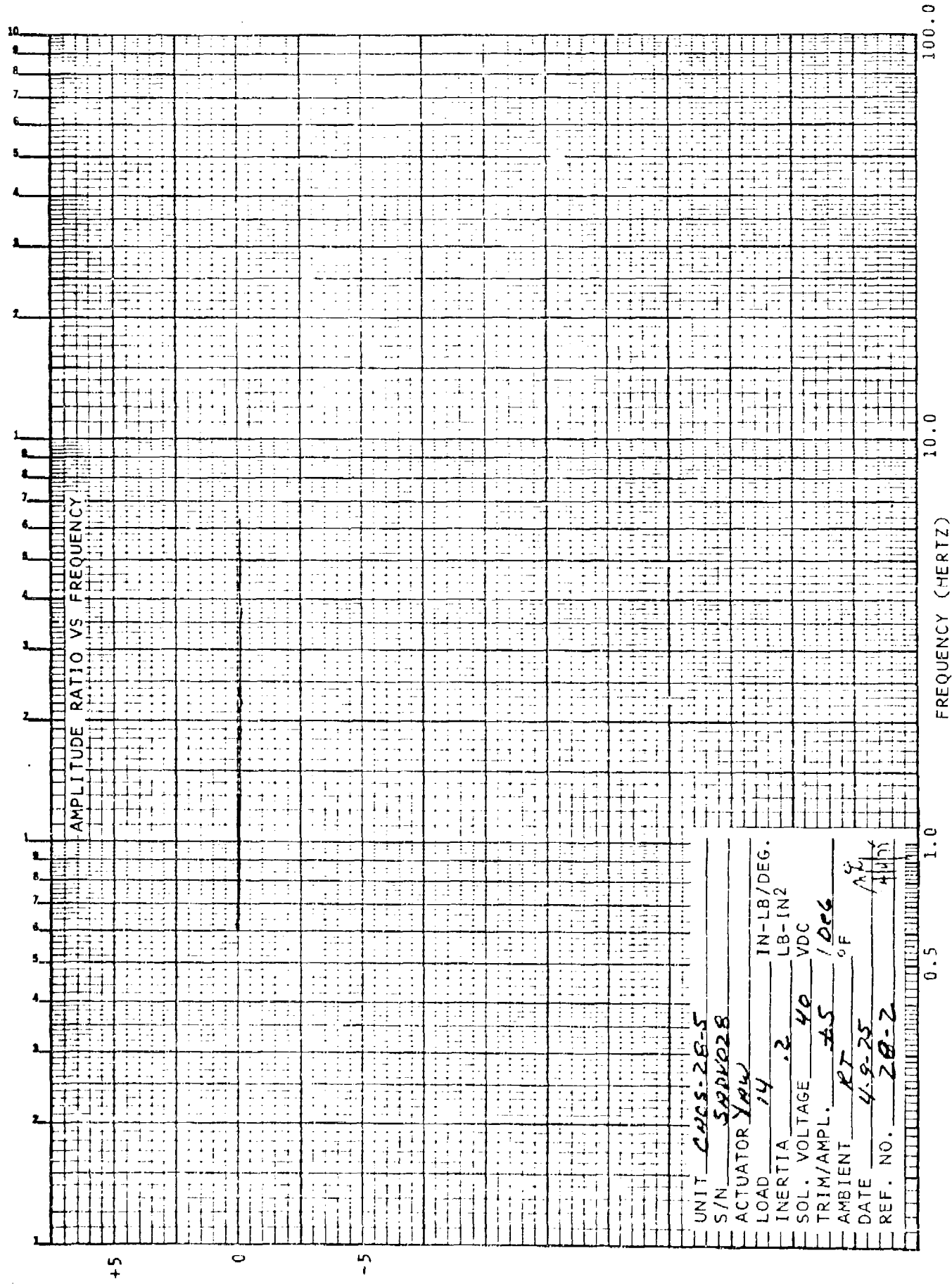
0.5 1.0

10.0

100.0



UNIT CACS-28-5
S/N 5801028
ACTUATOR PITCH
LOAD 14 IN-LB/DEG.
INERTIA .2 LB-IN²
SOL. VOLTAGE 40 VDC
TRIM/AMPL. 15 / 100
AMBIENT RT °F
DATE 4-9-75
REF. NO. 28-3



UNIT CACS-2B-5

S/N 5APK028

ACTUATOR YAW

LOAD

14

IN-LB/DEG.

LB-IN2

.2

VDC

40

TRIM/AMPL.

45

1006

AMBIENT

RT

°F

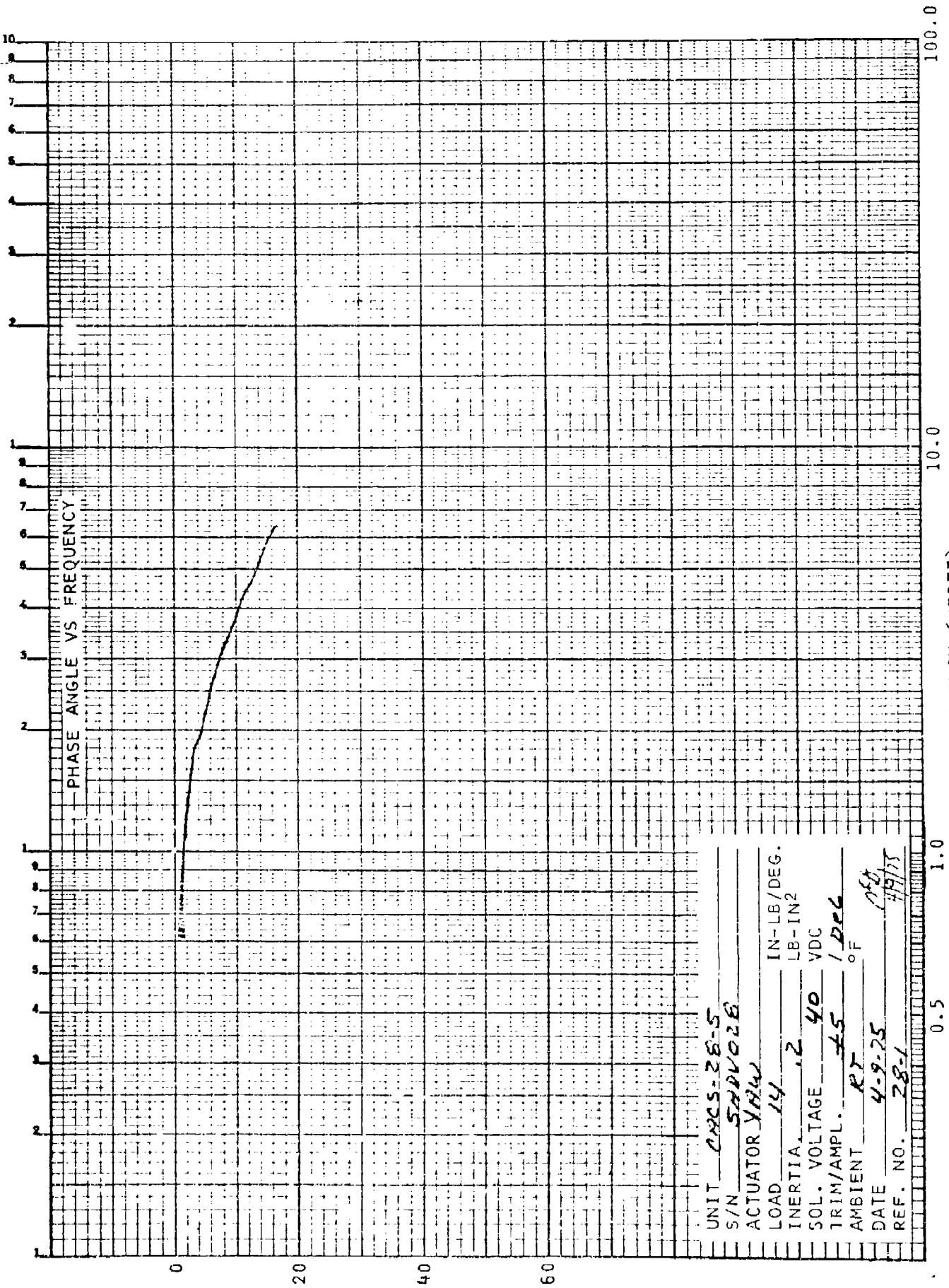
4.9-25

DATE

20-2

REF. NO.

407



UNIT CRCS-28-5
S/N 58DV028
ACTUATOR YRW
LOAD 14 IN-LB/DEG.
INERTIA .2 LB-IN²
SOL. VOLTAGE 40 VDC
TRIM/AMPL. ±5 OF
AMBIENT RT
DATE 4-9-75
REF. NO. 28-1

100.0
10.0
1.0
0.5

Colt Industries Inc

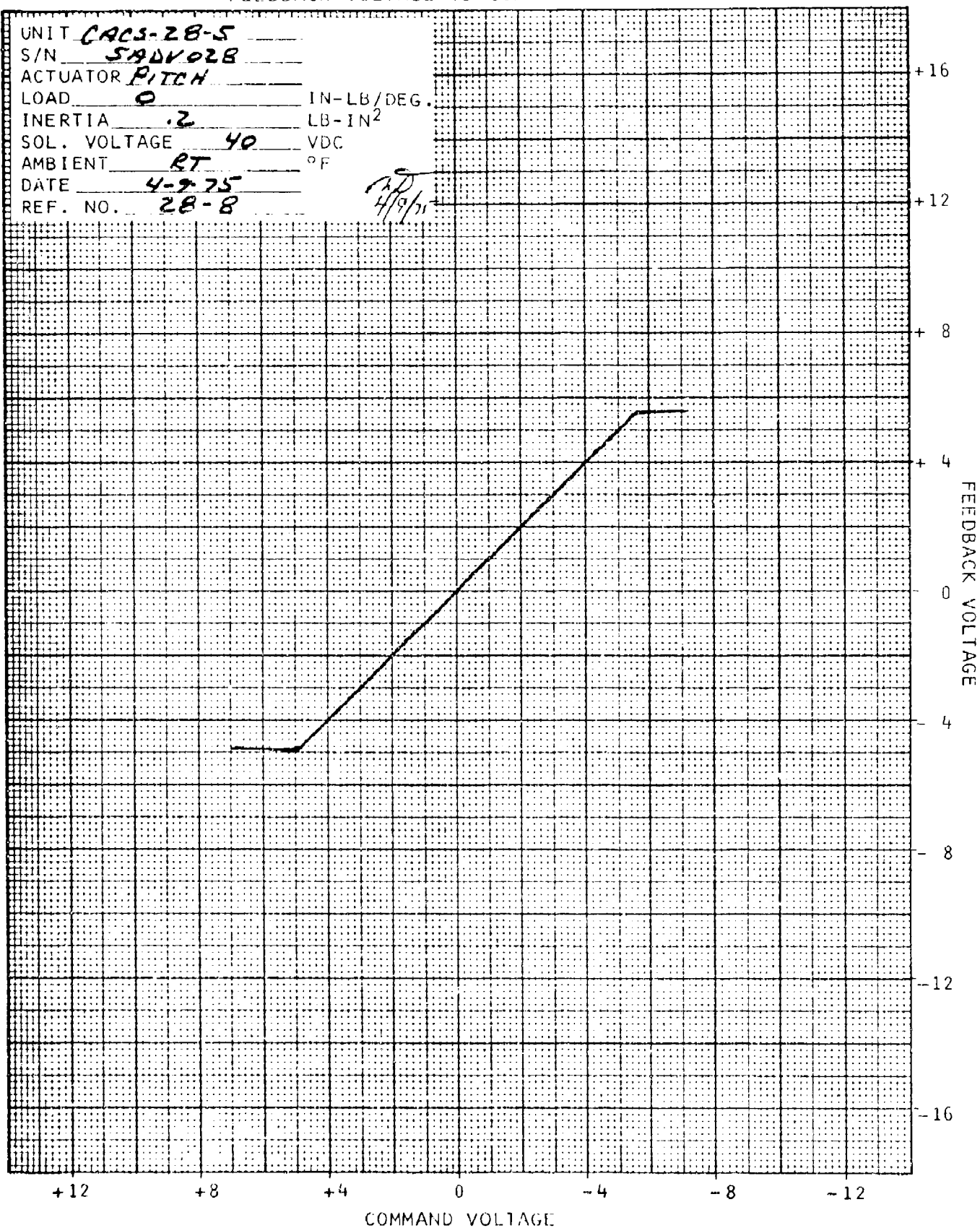


Chandler Evans Inc Control Systems Division WEST HARTFORD, CONNECTICUT 06101

FEEDBACK VOLTAGE VS COMMAND VOLTAGE

UNIT CACS-28-5
 S/N 5ADV028
 ACTUATOR PITCH
 LOAD 0 IN-LB/DEG.
 INERTIA .2 LB-IN²
 SOL. VOLTAGE 40 VDC
 AMBIENT RT °F
 DATE 4-9-75
 REF. NO. 28-8

AD
4/9/75



Colt Industries Inc

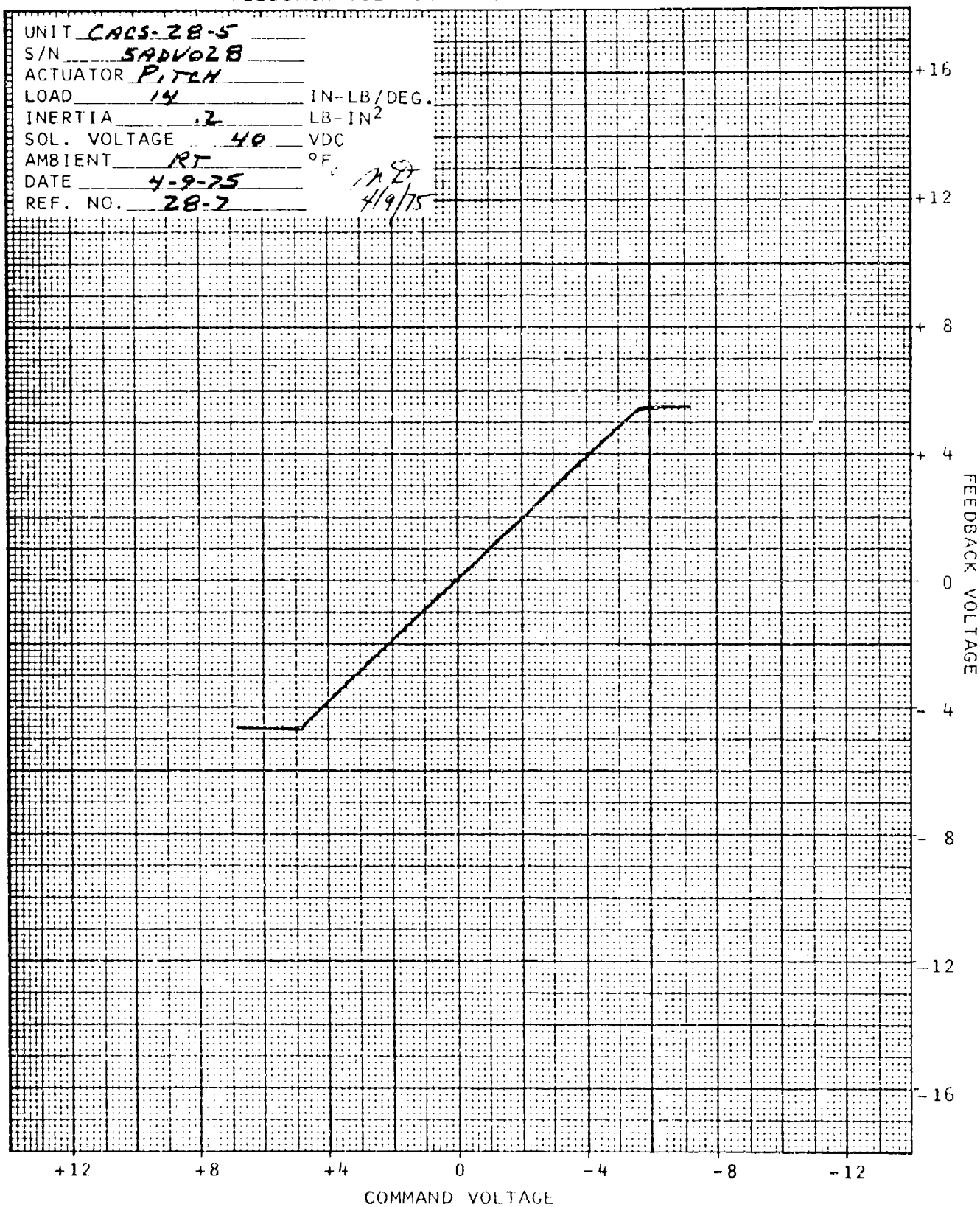


Chandler Evans Inc Control Systems Division WEST HARTFORD, CONNECTICUT 06101

FEEDBACK VOLTAGE VS COMMAND VOLTAGE

UNIT CACS-2B-5
S/N 5ADV02B
ACTUATOR PITCH
LOAD 14 IN-LB/DEG.
INERTIA .2 LB-IN²
SOL. VOLTAGE 40 VDC
AMBIENT RT °F
DATE 4-9-75
REF. NO. 28-7

MT
4/9/75



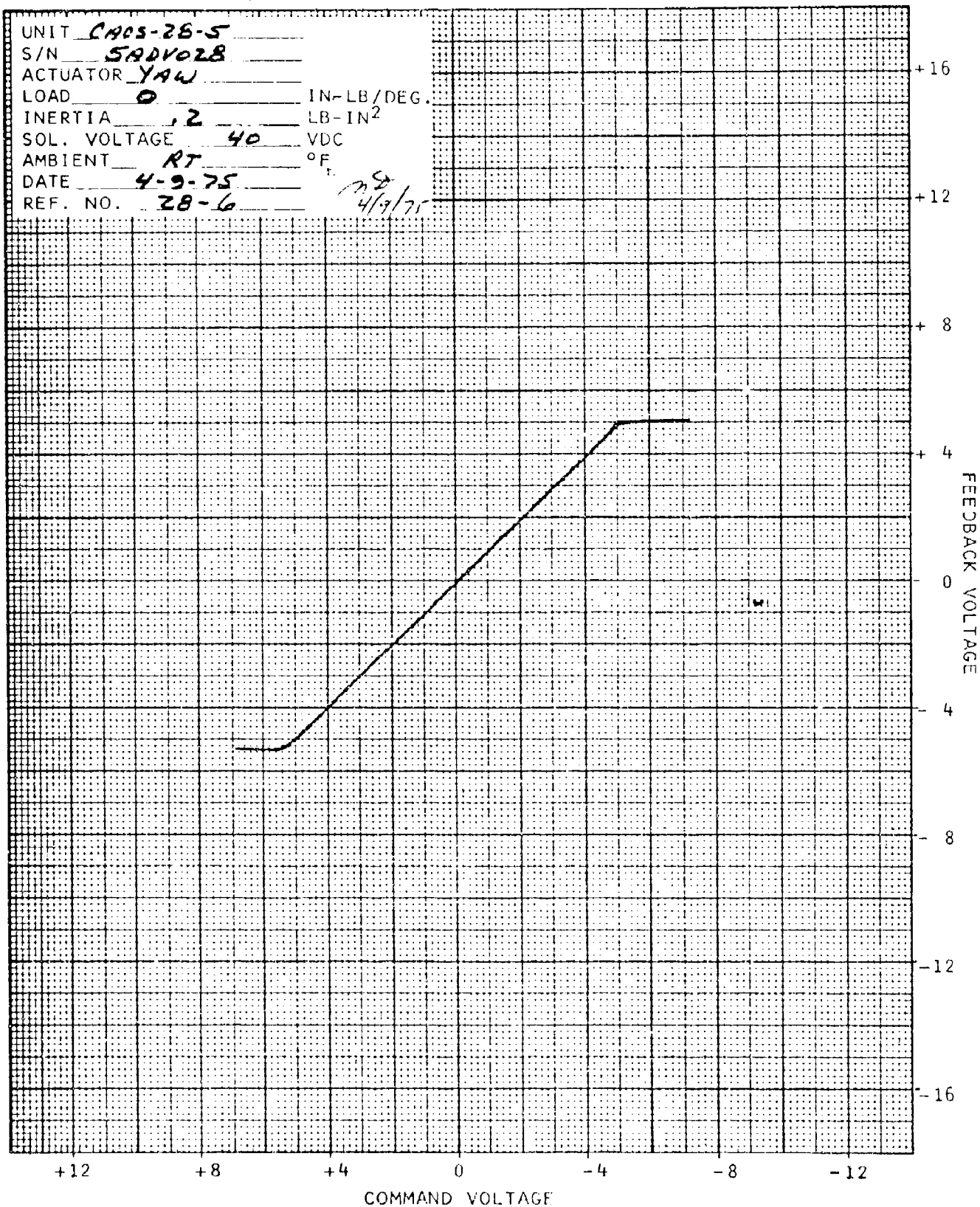
Colt Industries Inc.



Chandler Evans Inc. Control Systems Division

WEST HARTFORD, CONNECTICUT 06101

FEEDBACK VOLTAGE VS COMMAND VOLTAGE

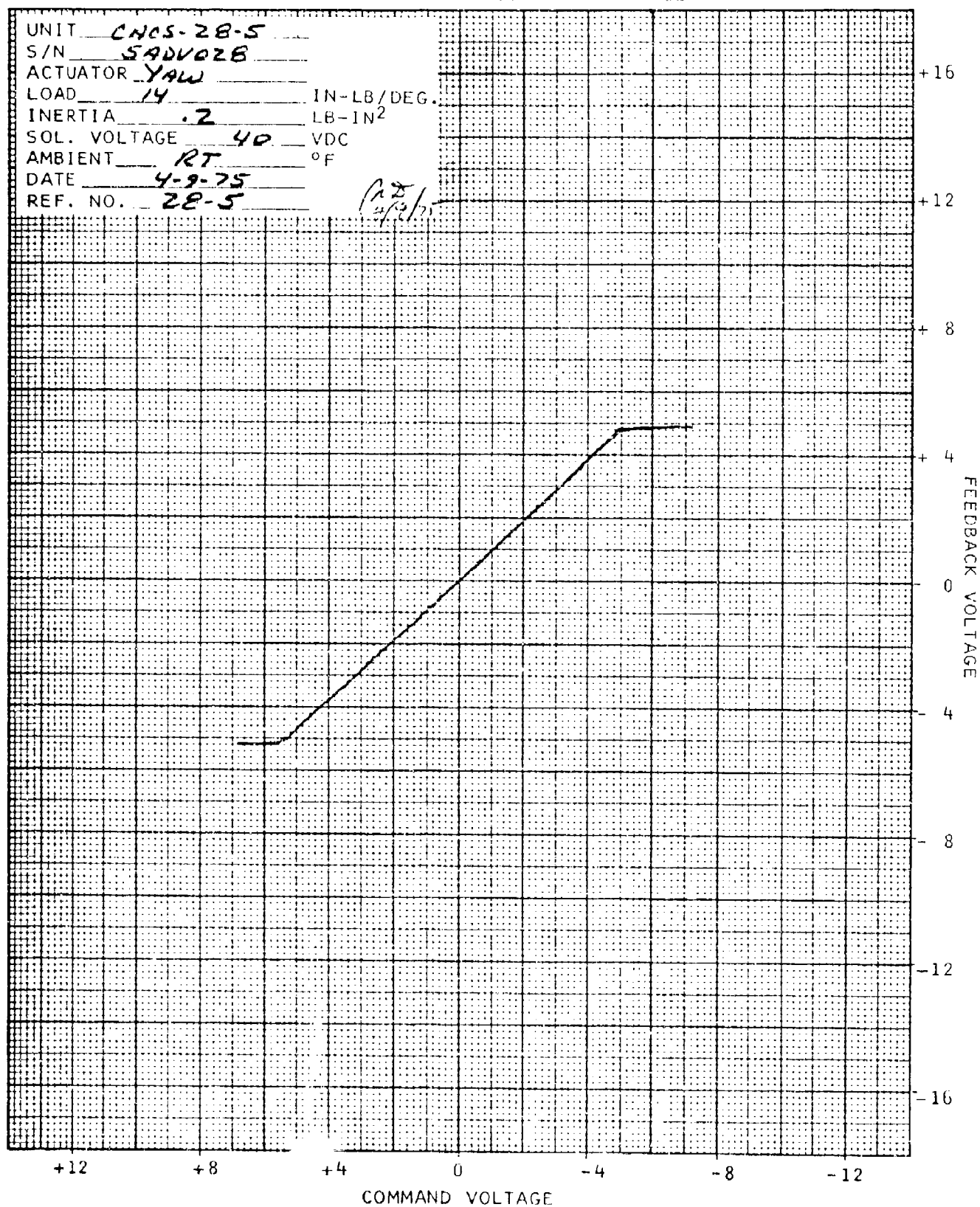


Colt Industries Inc



Chandler Evans Inc Control Systems Division WEST HARTFORD, CONNECTICUT 06101

FEEDBACK VOLTAGE VS COMMAND VOLTAGE



02581

COMMAND

191°/sec

YAW

252°/sec²
average

213°/sec

R

183°/sec

PITCH

225°/sec²
average

267°/sec

R

CACS- 28-5

S/N

5ADV028

ACTUATOR

BOTH

COIL

14

IN-LB/DEG.

INERTIA

0.2

LB-IN²

SOL. VOLTAGE

40

V.D.C.

TRIM/AMPL

±8

1.206

AMBIENT

RT

'F

DURATION

—

DATE

4-9-75

OPERATOR

EP

REF. NO.

REMARKS

TEST INSP

OK

4/9/75

ENG. REPORT NO. R-787 DATE June 9, 1975

APPENDIX B

GAS CONTAINER BLOWDOWN RESULTS

S/N	AMBIENT TEMP.	TOTAL DURATION (SECONDS)	CONFIGURATION	REMARKS
4ADV001	R _T	23.5	Canards Deployed	1 sec. commanded 2 Hz \pm 5° sq. wave. 22.5 secs. 50% Duty Cycle.
4ADV001	R _T	93	Loaded 14 in-lb/deg	10 secs. commanded 50% Duty Cycle 83 secs. stop to stop 1 Hz sq. wave.
4ADV001	-25°F	65	Loaded 14 in-lb/deg	8.5 secs. commanded 50% Duty Cycle 56.5 secs. stop to stop 1 Hz sq. wave.
4ADV002	R _T	24	Canard Deployed	Commanded 50% Duty Cycle except for 2 secs. of 1 Hz \pm 5 deg sine wave, 10 secs after initiation.
4ADV002	R _T	26	Loaded 14 in-lb/deg	Commanded 50% Duty Cycle for 10 secs. followed by 16 secs. of 1 Hz \pm 5 deg sine wave.
4ADV002	-25°F	75	Loaded 14 in-lb/deg	Commanded 50% Duty Cycle for 10 secs. followed by 65 secs. stop to stop 1 Hz sq. wave.
4ADV003	R _T	25	Canard Deployed	Commanded 50% Duty Cycle for 10 secs. followed by 15 secs. 1 Hz \pm 5 deg sine wave.
4ADV003	R _T	77	Loaded 14 in-lb/deg	Commanded 50% Duty Cycle for 9 secs., followed by 68 secs. stop to stop 1 Hz sq. wave.
4ADV004	R _T	26	Canards Deployed	Commanded 50% Duty Cycle for 10 secs., followed by 16 secs 1 Hz \pm 5 deg sine wave.

S/N	AMBIENT TEMP.	TOTAL DURATION (SECONDS)	CONFIGURATION	REMARKS
4ADV005	R _T	25	Canards Deployed	Commanded 50% Duty Cycle for 10 secs., followed by 15 secs. 1 Hz \pm 5 deg sine wave.
4ADV006	R _T	25	Canard Deployed	Commanded 50% Duty Cycle for 9.5 secs., followed by 15.5 secs. 1 Hz \pm 5 deg sine wave.